

## THE CLAIMS

I claim:

5                   1. A layered catalyst composite comprising a first layer and a second layer:

                 (a) the first layer comprising a first support and a first platinum component; and

10               (b) the second layer comprising a second support and a  $\text{SO}_x$  sorbent component having a free energy of formation from about 0 to about -90 Kcal/mole at 350°C.

15               2. The layered catalyst composite as recited in claim 1, wherein the first and second supports are the same or different and are compounds selected from the group consisting of silica, alumina, and titania compounds.

20               3. The layered catalyst composite as recited in claim 1, wherein the first and second supports are the same or different and are activated compounds selected from the group consisting of alumina, silica, silica-alumina, aluminosilicates, alumina-zirconia, alumina-chromia, alumina-titania, titania-zirconia, ceria-zirconia, lanthana-zirconia, and alumina-ceria.

25               4. The layered catalyst composite as recited in claim 3, wherein the first and second supports are activated alumina.

5. The layered catalyst composite as recited in claim 1, wherein the  $\text{SO}_x$  sorbent component has a free energy of formation from about 0 to about -60 Kcal/mole at 350°C.

30               6. The layered catalyst composite as recited in claim 5, wherein the  $\text{SO}_x$  sorbent component has a free energy of formation from about -30 to about -55 Kcal/mole at 350°C.

7. The layered catalyst composite as recited in claim 1, wherein the SO<sub>X</sub> sorbent component is selected from the group consisting of oxides and aluminum oxides of lithium, magnesium, calcium, manganese, iron, cobalt, nickel, 5 copper, zinc, and silver.

8. The layered catalyst composite as recited in claim 7, wherein the SO<sub>X</sub> sorbent component is selected from the group consisting of MgO, MgAl<sub>2</sub>O<sub>4</sub>, MnO, MnO<sub>2</sub>, and Li<sub>2</sub>O.

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9. The layered catalyst composite as recited in claim 8, wherein the SO<sub>X</sub> sorbent component is MgO or Li<sub>2</sub>O.

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10. The layered catalyst composite as recited in claim 1, wherein the first layer further comprises a first platinum group metal component other than platinum.

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11. The layered catalyst composite as recited in claim 10, wherein the first platinum group metal component is selected from the group consisting of palladium, rhodium, ruthenium, iridium, and mixtures thereof.

12. The layered catalyst composite as recited in claim 11, wherein the first platinum group metal component is palladium.

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13. The layered catalyst composite as recited in claim 1, wherein the second layer further comprises a second platinum group metal component.

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14. The layered catalyst composite as recited in claim 13, wherein the second platinum group metal component is selected from the group consisting of platinum, palladium, rhodium, ruthenium, iridium, and mixtures thereof.

15. The layered catalyst composite as recited in claim 14, wherein the second platinum group metal component is platinum.
16. The layered catalyst composite as recited in claim 13, wherein 5 the second layer further comprises a second platinum group metal component other than platinum.
17. The layered catalyst composite as recited in claim 16, wherein the second platinum group metal component is selected from the group consisting of 10 palladium, rhodium, ruthenium, iridium, and mixtures thereof.
18. The layered catalyst composite as recited in claim 1, wherein the first layer comprises at least about 1g/ft<sup>3</sup> of the first platinum component.
- 15 19. The layered catalyst composite as recited in claim 13, wherein the second layer comprises at least about 1g/ft<sup>3</sup> of the second platinum group component.
- 20 20. The layered catalyst composite as recited in claim 1, wherein the second layer comprises from about 0.03g/in<sup>3</sup> to about 2.4g/in<sup>3</sup> of the SO<sub>X</sub> sorbent component.
- 25 21. The layered catalyst composite as recited in claim 20, wherein the second layer comprises from about 0.3g/in<sup>3</sup> to about 1.8g/in<sup>3</sup> of the SO<sub>X</sub> sorbent component.
- 30 22. The layered catalyst composite as recited in claim 1, wherein the first layer further comprises a NO<sub>X</sub> sorbent component selected from the group consisting of alkaline earth metal components, alkali metal components, and rare earth metal components.

23. The layered catalyst composite as recited in claim 22, wherein the NO<sub>x</sub> sorbent component is selected from the group consisting of oxides of calcium, strontium, and barium, oxides of potassium, sodium, lithium, and cesium, and oxides of cerium, lanthanum, praseodymium, and neodymium.

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24. The layered catalyst composite as recited in claim 23, wherein the NO<sub>x</sub> sorbent component is selected from the group consisting of oxides of calcium, strontium, and barium.

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25. The layered catalyst composite as recited in claim 23, wherein the NO<sub>x</sub> sorbent component is selected from the group consisting of oxides of potassium, sodium, lithium, and cesium.

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26. The layered catalyst composite as recited in claim 23, wherein the NO<sub>x</sub> sorbent component is selected from the group consisting of oxides of cerium, lanthanum, praseodymium, and neodymium.

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27. The layered catalyst composite as recited in claim 22, wherein the NO<sub>x</sub> sorbent component is at least one alkaline earth metal component and at least one rare earth metal component selected from the group consisting of lanthanum and neodymium.

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28. The layered catalyst composite as recited in claim 1, wherein at least one of the first or second layers further comprises a zirconium component.

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29. The layered catalyst composite as recited in claim 1, comprising:

- (a) in the first layer;
  - (i) from about 0.15g/in<sup>3</sup> to about 2.7g/in<sup>3</sup> of the first support;
  - (ii) at least about 1g/ft<sup>3</sup> of the first platinum component;
  - (iii) at least about 1g/ft<sup>3</sup> of a first platinum group metal component other than platinum;

(iv) from about 0.025g/in<sup>3</sup> to about 0.7g/in<sup>3</sup> of a NO<sub>x</sub> sorbent component selected from the group consisting of alkaline earth metal oxides, alkali metal oxides, and rare earth metal oxides; and

(v) from about 0.025g/in<sup>3</sup> to about 0.7g/in<sup>3</sup> of a first zirconium component; and

5 (b) in the second layer;

(i) from about 0.15g/in<sup>3</sup> to about 2.7g/in<sup>3</sup> of the second support;

(ii) from about 0.3g/in<sup>3</sup> to about 1.8g/in<sup>3</sup> of the SO<sub>x</sub> sorbent component;

10 (iii) at least about 1g/ft<sup>3</sup> of a second platinum group component;

(iv) at least about 1g/ft<sup>3</sup> of a second platinum group metal component other than platinum; and

(v) from about 0.025g/in<sup>3</sup> to about 0.7g/in<sup>3</sup> of a second zirconium component.

15 30. The layered catalyst composite as recited in claim 29, wherein at least one of the first or second layers comprises from about 0.025g/in<sup>3</sup> to about 0.5g/in<sup>3</sup> of at least one rare earth metal component selected from the group consisting of lanthanum metal components and neodymium metal components.

20 31. The layered catalyst composite as recited in claim 1, wherein the composite is in the form of a pellet with the first layer on the inside and the second layer on the outside of the pellet.

25 32. The layered catalyst composite as recited in claim 1, wherein the first layer is supported on a substrate and the second layer is supported on the first layer opposite the substrate.

30 33. The layered catalyst composite as recited in claim 32, wherein the substrate comprises a honeycomb carrier.

34. An axial layered catalyst composite comprising an upstream section and a downstream section:

(1) the downstream section comprising:

(a) a downstream substrate; and

5 (b) a first layer on the downstream substrate, the first layer comprising a first support and a first platinum component;

(2) the upstream section comprising:

(a) an upstream substrate; and

10 (b) a second layer on the upstream substrate, the second layer comprising a second support and a  $\text{SO}_x$  sorbent component having a free energy of formation from about 0 to about -90 Kcal/mole at 350°C.

15 35. The axial layered catalyst composite as recited in claim 34, wherein the upstream section and downstream section are the upstream section and downstream sections of a single substrate.

36. The axial layered catalyst composite as recited in claim 35, wherein the single substrate is a honeycomb substrate.

20 37. The axial layered catalyst composite as recited in claim 34, wherein the upstream section comprises an upstream substrate and the downstream section comprises a downstream substrate, separate from the upstream substrate.

25 38. The axial layered catalyst composite as recited in claim 37, wherein the upstream substrate and downstream substrate are honeycomb substrates.

39. The axial layered catalyst composite as recited in claim 34, wherein the  $\text{SO}_x$  sorbent component has a free energy of formation from about 0 to about -60 Kcal/mole at 350°C.

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40. The axial layered catalyst composite as recited in claim 34, wherein the  $\text{SO}_x$  sorbent component is selected from the group consisting of oxides

and aluminum oxides of lithium, magnesium, calcium, manganese, iron, cobalt, nickel, copper, zinc, and silver.

41. The axial layered catalyst composite as recited in claim 40,  
5 wherein the  $\text{SO}_x$  sorbent component is selected from the group consisting of  $\text{MgO}$ ,  $\text{MgAl}_2\text{O}_4$ ,  $\text{MnO}$ ,  $\text{MnO}_2$ , and  $\text{Li}_2\text{O}$ .

42. The axial layered catalyst composite as recited in claim 41,  
wherein the  $\text{SO}_x$  sorbent component is  $\text{MgO}$  or  $\text{Li}_2\text{O}$ .

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43. The axial layered catalyst composite as recited in claim 34,  
wherein the first layer further comprises a first platinum group metal component  
other than platinum.

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44. The axial layered catalyst composite as recited in claim 34,  
wherein the second layer further comprises a second platinum group metal  
component.

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45. The axial layered catalyst composite as recited in claim 44,  
wherein the second layer further comprises a second platinum group metal  
component other than platinum.

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46. The axial layered catalyst composite as recited in claim 34,  
wherein the first layer further comprises a  $\text{NO}_x$  sorbent component selected from the  
group consisting of alkaline earth metal components, alkali metal components, and  
rare earth metal components.

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47. The axial layered catalyst composite as recited in claim 34,  
wherein at least one of the first or second layers further comprises a zirconium  
component.

48. The axial layered catalyst composite as recited in claim 34, comprising:

(a) in the first layer;

- (i) from about 0.15g/in<sup>3</sup> to about 2.0g/in<sup>3</sup> of the first support;
- 5 (ii) at least about 1g/ft<sup>3</sup> of the first platinum component;
- (iii) at least about 1g/ft<sup>3</sup> of a first platinum group metal component other than platinum;
- 10 (iv) from about 0.025g/in<sup>3</sup> to about 0.5g/in<sup>3</sup> of a NO<sub>X</sub> sorbent component selected from the group consisting of alkaline earth metal oxides, alkali metal oxides, and rare earth metal oxides; and
- (v) from about 0.025g/in<sup>3</sup> to about 0.5g/in<sup>3</sup> of a first zirconium component; and

(b) in the second layer;

- (i) from about 0.15g/in<sup>3</sup> to about 2.0g/in<sup>3</sup> of the second support;
- 15 (ii) from about 0.3g/in<sup>3</sup> to about 1.8g/in<sup>3</sup> of the SO<sub>X</sub> sorbent component;
- (iii) at least about 1g/ft<sup>3</sup> of a second platinum group component;
- (iv) at least about 1g/ft<sup>3</sup> of a second platinum group metal component other than platinum; and
- 20 (v) from about 0.025g/in<sup>3</sup> to about 0.5g/in<sup>3</sup> of a second zirconium component.

49. The axial layered catalyst composite as recited in claim 34, wherein

- 25 (1) the first layer on the downstream substrate further comprises a NO<sub>X</sub> sorbent component selected from the group consisting of cesium components, potassium components, and cerium components; and
- (2) the second layer on the upstream substrate comprises a SO<sub>X</sub> sorbent component which is MgAl<sub>2</sub>O<sub>4</sub>; and
- 30 further comprising a first midstream section located between the upstream section and the downstream section:
- (3) the first midstream section comprising:

- (a) a first midstream substrate; and
- (b) a third layer on the first midstream substrate, the third layer comprising:
  - (i) a third support; and
  - 5 (ii) a third  $\text{SO}_x$  sorbent component which is selected from the group consisting of  $\text{BaO}$  and  $\text{MgO}$ .

50. The axial layered catalyst composite as recited in claim 49, wherein the third  $\text{SO}_x$  sorbent component in the third layer is  $\text{BaO}$ .

10 51. The axial layered catalyst composite as recited in claim 49, wherein the third  $\text{SO}_x$  sorbent component in the third layer is  $\text{MgO}$ .

52. The axial layered catalyst composite as recited in claim 49, 15 wherein the  $\text{NO}_x$  sorbent component in the first layer is a composite of  $\text{Cs}_2\text{O}/\text{K}_2\text{O}/\text{CeO}_2$ .

53. The axial layered catalyst composite as recited in claim 49, 20 wherein the third layer further comprises a third platinum group metal component.

54. The axial layered catalyst composite as recited in claim 53, wherein the third layer further comprises a third platinum group metal component other than platinum.

25 55. The axial layered catalyst composite as recited in claim 49, wherein the third layer further comprises a zirconium component.

56. The axial layered catalyst composite as recited in claim 49, 30 wherein

- (1) the third layer on the first midstream substrate comprises a third  $\text{SO}_x$  sorbent component which is  $\text{MgO}$ ; and

further comprising a second midstream section located between the downstream section and the first midstream section:

(2) the second midstream section comprising:

(a) a second midstream substrate; and

5 (b) a fourth layer on the second midstream substrate, the fourth layer comprising:

(i) a fourth support;

(ii) a fourth  $\text{SO}_X$  sorbent which is  $\text{BaO}$ .

10 57. The axial layered catalyst composite as recited in claim 56, wherein the fourth layer further comprises a fourth platinum group metal component.

15 58. The axial layered catalyst composite as recited in claim 57, wherein the fourth layer further comprises a fourth platinum group metal component other than platinum.

59. The axial layered catalyst composite as recited in claim 56, wherein the fourth layer further comprises a zirconium component.

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60. A radial layered catalyst composite comprising a bottom layer, a first middle layer, and a top layer:

(a) the bottom layer comprising:

(i) a first support;

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(ii) a first platinum component;

(iii) a first  $\text{NO}_X$  sorbent component selected from the group consisting of cesium components, potassium components, and cerium components; and

(b) the first middle layer comprising:

(i) a second support;

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(ii) a second  $\text{SO}_X$  sorbent component which is selected from the group consisting of  $\text{BaO}$  and  $\text{MgO}$ ; and

(c) the top layer comprising:

- (i) a third support;
- (ii) a third  $\text{SO}_x$  sorbent component which is  $\text{MgAl}_2\text{O}_4$ .

61. The radial layered catalyst composite as recited in claim 60,  
5 wherein the first  $\text{NO}_x$  sorbent component in the bottom layer is a composite of  
 $\text{Cs}_2\text{O}/\text{K}_2\text{O}/\text{CeO}_2$ .

62. The radial layered catalyst composite as recited in claim 60,  
wherein the second  $\text{SO}_x$  sorbent component in the first middle layer is  $\text{BaO}$ .

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63. The radial layered catalyst composite as recited in claim 60,  
wherein the second  $\text{SO}_x$  sorbent component in the first middle layer is  $\text{MgO}$ .

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64. The radial layered catalyst composite as recited in claim 60,  
wherein the first middle layer further comprises a second platinum group metal  
component.

65. The radial layered catalyst composite as recited in claim 60,  
wherein the top layer further comprises a third platinum group metal component.

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66. The radial layered catalyst composite as recited in claim 60,  
wherein the bottom layer further comprises a first platinum group metal component  
other than platinum.

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67. The radial layered catalyst composite as recited in claim 64,  
wherein the first middle layer further comprises a second platinum group metal  
component other than platinum.

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68. The radial layered catalyst composite as recited in claim 65,  
wherein the top layer further comprises a third platinum group metal component  
other than platinum.

69. The radial layered catalyst composite as recited in claim 60, wherein at least one of the bottom, first middle, or top layers further comprises a zirconium component.

5                   70. The radial layered catalyst composite as recited in claim 60, wherein the first middle layer (b) comprises a  $\text{SO}_x$  sorbent component which is  $\text{MgO}$ ; and further comprising a second middle layer located between the bottom layer and the first middle layer:

10                 (d) the second middle layer comprising:  
                      (i) a fourth support; and  
                      (ii) a  $\text{SO}_x$  sorbent component which is  $\text{BaO}$  or  $\text{MgO}$ .

15                 71. The radial layered catalyst composite as recited in claim 70, wherein the second middle layer further comprises a fourth platinum group metal component.

20                 72. The radial layered catalyst composite as recited in claim 71, wherein the second middle layer further comprises a fourth platinum group metal component other than platinum.

73. The radial layered catalyst composite as recited in claim 70, wherein the second middle layer further comprises a zirconium component.

25                 74. A method for removing  $\text{NO}_x$  and  $\text{SO}_x$  contaminants from a gaseous stream comprising the steps of:

                      (A) in a sorbing period, passing a lean gaseous stream within a sorbing temperature range through a layered catalyst composite comprising a first layer and a second layer:

30                 (a) the first layer comprising a first support and a first platinum component; and

(b) the second layer comprising a second support and a  $\text{SO}_x$  sorbent component having a free energy of formation from about 0 to about -90 Kcal/mole at  $350^\circ\text{C}.$ ;

5 to sorb at least some of the  $\text{SO}_x$  contaminants into the second layer and thereby provide a  $\text{SO}_x$  depleted gaseous stream exiting the second layer and entering the first layer, wherein the first layer sorbs and abates the  $\text{NO}_x$  in the gaseous stream; and

(B) in a desorbing period, converting the lean oxidative stream to a rich reductive gaseous stream and raising the temperature of the gaseous stream to within a desorbing temperature range to thereby reduce and desorb at least some of the  $\text{SO}_x$  10 contaminants from the second layer and thereby provide a  $\text{SO}_x$  enriched gaseous stream exiting the second layer.

15 75. The method as recited in claim 74, wherein the first and second supports are the same or different and are compounds selected from the group consisting of silica, alumina, and titania compounds.

20 76. The method as recited in claim 74, wherein the first and second supports are the same or different and are activated compounds selected from the group consisting of alumina, silica, silica-alumina, alumino-silicates, alumina-zirconia, alumina-chromia, and alumina-ceria.

25 77. The method as recited in claim 76, wherein the first and second supports are activated alumina.

78. The method as recited in claim 74, wherein the  $\text{SO}_x$  sorbent component has a free energy of formation from about 0 to about -60 Kcal/mole at  $350^\circ\text{C}.$

30 79. The method as recited in claim 78, wherein the  $\text{SO}_x$  sorbent component has a free energy of formation from about -30 to about -55 Kcal/mole at  $350^\circ\text{C}.$

80. The method as recited in claim 74, wherein the SO<sub>X</sub> sorbent component is selected from the group consisting of oxides and aluminum oxides of lithium, magnesium, calcium, manganese, iron, cobalt, nickel, copper, zinc, and silver.

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81. The method as recited in claim 80, wherein the SO<sub>X</sub> sorbent component is selected from the group consisting of MgO, MgAl<sub>2</sub>O<sub>4</sub>, MnO, MnO<sub>2</sub>, and Li<sub>2</sub>O.

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82. The method as recited in claim 81, wherein the SO<sub>X</sub> sorbent component is MgO or Li<sub>2</sub>O.

83. The method as recited in claim 74, wherein the first layer further comprises a first platinum group metal component other than platinum.

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84. The method as recited in claim 83, wherein the first platinum group metal component is selected from the group consisting of palladium, rhodium, ruthenium, iridium, and mixtures thereof.

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85. The method as recited in claim 84, wherein the first platinum group metal component is palladium.

86. The method as recited in claim 74, wherein the second layer further comprises a second platinum group metal component.

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87. The method as recited in claim 86, wherein the second platinum group metal component is selected from the group consisting of platinum, palladium, rhodium, ruthenium, iridium, and mixtures thereof.

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88. The method as recited in claim 87, wherein the second platinum group metal component is platinum.

89. The method as recited in claim 86, wherein the second layer further comprises a second platinum group metal component other than platinum.

90. The method as recited in claim 89, wherein the second platinum group metal component is selected from the group consisting of palladium, rhodium, ruthenium, iridium, and mixtures thereof.

91. The method as recited in claim 74, wherein the first layer comprises at least about 1g/ft<sup>3</sup> of the first platinum component.

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92. The method as recited in claim 86, wherein the second layer comprises at least about 1g/ft<sup>3</sup> of the second platinum group component.

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93. The method as recited in claim 74, wherein the second layer comprises from about 0.03g/in<sup>3</sup> to about 2.4g/in<sup>3</sup> of the SO<sub>X</sub> sorbent component.

94. The method as recited in claim 93, wherein the second layer comprises from about 0.3g/in<sup>3</sup> to about 1.8g/in<sup>3</sup> of the SO<sub>X</sub> sorbent component.

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95. The method as recited in claim 74, wherein the first layer further comprises a NO<sub>X</sub> sorbent component selected from the group consisting of alkaline earth metal components, alkali metal components, and rare earth metal components.

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96. The method as recited in claim 95, wherein the NO<sub>X</sub> sorbent component is selected from the group consisting of oxides of calcium, strontium, and barium, oxides of potassium, sodium, lithium, and cesium, and oxides of cerium, lanthanum, praseodymium, and neodymium.

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97. The method as recited in claim 96, wherein the NO<sub>X</sub> sorbent component is selected from the group consisting of oxides of calcium, strontium, and barium.

98. The method as recited in claim 96, wherein the NO<sub>X</sub> sorbent component is selected from the group consisting of oxides of potassium, sodium, lithium, and cesium.

5 99. The method as recited in claim 96, wherein the NO<sub>X</sub> sorbent component is selected from the group consisting of oxides of cerium, lanthanum, praseodymium, and neodymium.

10 100. The method as recited in claim 96, wherein the NO<sub>X</sub> sorbent component is at least one alkaline earth metal component and at least one rare earth metal component selected from the group consisting of lanthanum and neodymium.

15 101. The method as recited in claim 74, wherein at least one of the first or second layers further comprises a zirconium component.

102. A method for removing NO<sub>X</sub> and SO<sub>X</sub> contaminants from a gaseous stream comprising the steps of:

20 (A) in a sorbing period, passing a lean gaseous stream within a sorbing temperature range through an axial layered catalyst composite comprising an upstream section and a downstream section:

(1) the downstream section comprising:

(a) a downstream substrate; and

(b) a first layer on the downstream substrate, the first layer comprising a first support and a first platinum component;

25 (2) the upstream section comprising:

(a) an upstream substrate; and

(b) a second layer on the upstream substrate, the second layer comprising a second support and a SO<sub>X</sub> sorbent component having a free energy of formation from about 0 to about -90 Kcal/mole at 350°C.;

30 to sorb at least some of the SO<sub>X</sub> contaminants into the upstream section and thereby provide a SO<sub>X</sub> depleted gaseous stream exiting the upstream section and entering the

downstream section, wherein the downstream section sorbs and abates the NO<sub>X</sub> in the gaseous stream; and

5 (B) in a desorbing period, converting the lean oxidative gaseous stream to a rich reductive gaseous stream and raising the temperature of the gaseous stream to within a desorbing temperature range to thereby reduce and desorb at least some of the SO<sub>X</sub> contaminants from the upstream section and thereby provide a SO<sub>X</sub> enriched gaseous stream exiting the upstream section.

103. The method as recited in claim 102, wherein

10 (1) the first layer on the downstream substrate further comprises a NO<sub>X</sub> sorbent component selected from the group consisting of cesium components, potassium components, and cerium components; and

15 (2) the second layer on the upstream substrate comprises a SO<sub>X</sub> sorbent component which is MgAl<sub>2</sub>O<sub>4</sub>; and further comprising a first midstream section located between the upstream section and the downstream section:

20 (3) the first midstream section comprising:  
(a) a first midstream substrate; and  
(b) a third layer on the first midstream substrate, the third layer comprising:

(i) a third support; and  
(ii) a third SO<sub>X</sub> sorbent component which is selected from the group consisting of BaO and MgO;  
to sorb at least some of the SO<sub>X</sub> contaminants into the first midstream section and thereby provide a SO<sub>X</sub> depleted gaseous stream exiting the first midstream section and entering the downstream section, wherein the downstream section sorbs and abates the NO<sub>X</sub> in the gaseous stream; and

25 (B) in a desorbing period, converting the lean gaseous stream to a rich gaseous stream and raising the temperature of the gaseous stream to within a desorbing temperature range to thereby reduce and desorb at least some of the SO<sub>X</sub> contaminants from the first midstream section and thereby provide a SO<sub>X</sub> enriched gaseous stream exiting the first midstream section.

104. A method for removing  $\text{NO}_x$  and  $\text{SO}_x$  contaminants from a gaseous stream comprising the steps of:

5 (A) in a sorbing period, passing a lean gaseous stream within a sorbing temperature range through a radial layered catalyst composite comprising a bottom layer, a first middle layer, and a top layer:

(a) the bottom layer comprising:

- (i) a first support;
- (ii) a first platinum component;

10 (iii) a first  $\text{NO}_x$  sorbent component selected from the group consisting of cesium components, potassium components, and cerium components; and

(b) the first middle layer comprising:

- (i) a second support;
- (ii) a second  $\text{SO}_x$  sorbent component which is selected from the group consisting of  $\text{BaO}$  and  $\text{MgO}$ ; and

(c) the top layer comprising:

- (i) a third support;
- (ii) a third  $\text{SO}_x$  sorbent component which is  $\text{MgAl}_2\text{O}_4$ ;

20 to sorb at least some of the  $\text{SO}_x$  contaminants into the top and first middle layers and thereby provide a  $\text{SO}_x$  depleted gaseous stream exiting the top and first middle layers and entering the bottom layer, wherein the bottom layer sorbs and abates the  $\text{NO}_x$  in the gaseous stream; and

25 (B) in a desorbing period, converting the lean gaseous stream to a rich gaseous stream and raising the temperature of the gaseous stream to within a desorbing temperature range to thereby reduce and desorb at least some of the  $\text{SO}_x$  contaminants from the top and first middle layers and thereby provide a  $\text{SO}_x$  enriched gaseous stream exiting the top and first middle layers.

105. The method as recited in claim 104, wherein

30 (3) the first middle layer comprises a  $\text{SO}_x$  sorbent component which is  $\text{MgO}$ ; and

further comprising a second middle layer located between the bottom layer and the first middle layer:

(d) the second middle layer comprising:

(i) a fourth support; and

5 (ii) a  $\text{SO}_X$  sorbent component which is  $\text{BaO}$ ;

to sorb at least some of the  $\text{SO}_X$  contaminants into the second middle layer and thereby provide a  $\text{SO}_X$  depleted gaseous stream exiting the second middle layer and entering the bottom layer, wherein the bottom layer sorbs and abates the  $\text{NO}_X$  in the gaseous stream; and

10 (B) in a desorbing period, converting the lean gaseous stream to a rich gaseous stream and raising the temperature of the gaseous stream to within a desorbing temperature range to thereby reduce and desorb at least some of the  $\text{SO}_X$  contaminants from the second middle layer and thereby provide a  $\text{SO}_X$  enriched gaseous stream exiting the second layer.

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106. A method of forming a layered catalyst composite which comprises the steps of:

(a) forming a first layer comprising:

(i) a first support; and

20 (ii) a first platinum component; and

(b) coating the first layer with a second layer comprising:

(i) a second support; and

(ii) a  $\text{SO}_X$  sorbent component having a free energy of formation from about 0 to about -90 Kcal/mole at 350°C.

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107. The method as recited in claim 106, wherein the first layer further comprises a first platinum group metal component other than a platinum component, a  $\text{NO}_X$  sorbent component selected from the group consisting of alkaline earth metal components, alkali metal components, and rare earth metal components, 30 and a first zirconium component.

108. The method as recited in claim 106, wherein the second layer further comprises a second platinum component, a second platinum group metal component other than platinum, and a second zirconium component.

5 109. A method of forming a layered catalyst composite which comprises the steps of:

10 (a) combining a water-soluble or dispersible first platinum component and a finely divided, high surface area refractory oxide with an aqueous liquid to form a first solution or dispersion which is sufficiently dry to absorb essentially all of the liquid;

(b) forming a first layer of the first solution or dispersion on a substrate;

(c) converting the first platinum component in the resulting first layer to a water-insoluble form;

15 (d) combining a water-soluble or dispersible  $\text{SO}_x$  sorbent component having a free energy of formation from about 0 to about -90 Kcal/mole at 350°C., and a finely divided, high surface area refractory oxide with an aqueous liquid to form a second solution or dispersion which is sufficiently dry to absorb essentially all of the liquid;

20 (e) forming a second layer of the second solution or dispersion on the first layer; and

(f) converting the second platinum component in the resulting second layer to a water-insoluble form.

25 110. The method as recited in claim 109, wherein the first solution or dispersion further comprises a first platinum group metal component other than a platinum component, a  $\text{NO}_x$  sorbent component selected from the group consisting of alkaline earth metal components, alkali metal components, and rare earth metal components, and a first zirconium component.

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111. The method as recited in claim 109, wherein the second solution or dispersion further comprises a second platinum component, a second

platinum group metal component other than platinum, and a second zirconium component.

112. The method as recited in claim 109, wherein the step of  
5 converting the first platinum component comprises calcining the first layer.

113. The method as recited in claim 111, wherein the step of  
converting the second platinum component and second platinum group metal  
component other than platinum comprises calcining the second layer.

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114. The method as recited in claim 111, further comprising the  
steps of:

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(i) comminuting the water-insoluble, first platinum component in a  
first coat slurry, forming a first layer of the first slurry, and drying the first slurry;  
and

(ii) comminuting the water-insoluble, second platinum components in  
a second coat slurry, forming a second layer of the second slurry on the first layer,  
and drying the second slurry.

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115. The method as recited claim 114, wherein the comminuting  
provides a slurry in which most of the solids have particle sizes of less than about 10  
microns.

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116. The method as recited claim 115, wherein at least one of the  
first and second slurries contains acetic acid or nitric acid.

117. The method as recited in claim 114, wherein the first platinum  
component and second platinum components are platinum nitrate.

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118. The method as recited in claim 109, further comprising the step  
of forming the first layer on a honeycomb substrate.